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# RESEARCH TREND OF MEDICAL BACTERIOLOGY

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DURING the last three years, conservative bacteriology has shown increasing discontent with nineteenth century theories of microbic infection and bodily resistance, a receptive attitude toward newly suggested hypotheses and alternative interpretations.

The suggested theories would offer plausible explanations for clinical non-success in the past and renewed hope of ultimate clinical victory.

## I

Fifty years ago, clinicians were introduced to a new biological world. Mid-Victorian microscopists intuitively pictured the newly discovered disease germs as miniature animals or midget plants. Thus pictured, it was perhaps inevitable that they should have read into these minute pathogenic specks many of the laws and generalizations of higher biological science.

Centuries of dwindling superstition had taught modern man that, from generation to generation, each higher plant and animal species is almost static in anatomical structure and physiological peculiarities. Minor variations, of course, were known to occur. Since the Middle Ages, however, rats had never been known to transmute into lizards, to fractionate into locusts, nor to evaporate into corrosive miasmas. It seemed logical to assume that this stability is in obedience to a general law of nature, equally applicable to microbic life. Obeying this static law a tubercle bacillus could never arise except from a preexistent bacillus of approximately the same morphology and chemical composition. A diphtheria bacillus could never transmute into a gonococcus, nor fractionate into ultramicroscopic poliomyelitis colloids.

This static purpose of nature became a major premise for subsequent epidemiologic, diagnostic and therapeutic deductions. Tuberculosis, gonorrhoea and poliomyelitis were wholly unrelated infectious diseases, because of the postulated microbic invariability.

Test-tube vaccines were logical therapies because artificial cultures were assumed to be biochemically identical with the corresponding natural infections. Antiserums prepared by immunizing horses against such vaccines were also logical and for the same reason.

A quite different infectious logic might have developed if the early microscopists had turned to the known facts of histology for their basic analogies, to tissue cells which like bacteria multiply by simple cell-division. From a single fertilized ovum a hundred different cell types were known to develop. Atypical mitoses, asymmetrical cell-divisions, cellular fusions, embryonic reversions, hetero-regenerations, dwarfisms, giantisms and functional metaplasias were the commonplace of cellular pathology. Morphological, functional and chemical transmutability of microbes rather than their invariability might have been the assumed law of clinical medicine. An artificial culture of the tubercle bacillus would have been tested as a hoped-for specific vaccine. This test, however, would not have been made with the preconception that this bacillus must necessarily possess the qualitative biochemical invariability necessary for vaccine success.

The static bacteriology of Pasteur, Ehrlich and Koch led to diphtheria antitoxin, the most spectacular therapeutic victory of all ages. Each victory of this type, however, was eventually paralleled by a half dozen diagnostic paradoxes and therapeutic failures. Tetanus partially surrendered, but tuberculosis and streptococcus mocked at nineteenth century infectious logic.

In spite of accumulating disappointments of this type, however, the static microbiology of the 1880's was not seriously questioned for nearly forty years. A few impatient Löhnises[1] dared report evidence in favor of limited microbic transmutability. Such reports, however, were not taken seriously.

Two years ago, however, Hadley[2] dared champion the "Löhnis phenomenon," and was, in his own language, "sufficiently foolhardy" to summarize previous "pleomorphic" data and supplement it by his own laboratory evidence. Hadley's paper released a flood of confirmatory reports. Orderly or disorderly pleomorphism rather than morphological invariability became an accepted possibility of microbic life, though bacteriologists were and still are far from agreement in their interpretations of the reported "mutations" or "involutions." The "dissociation" of a score or more pure bacterial strains into two or more morphological, tinctorial or cultural "variants" is now well confirmed. Bacterial "dwarfism," "fragmentation" or even complete "disintegration" into almost invisible, viable micromidgets is no longer seriously questioned. "Life cycles," "hibernating phases," "conjugations," "primordial revisions" and "free gonidial units" are suggested terms now asking official endorsement.

That the bacterial colony and not the individual bacillus is the essential physiological unit or microbic growth is probably the most radical of these suggestions, the colony pictured as a primordial multicellular plant. Purposeful differentiations, orderly life cycles, resting stages, nutritional and hormonal integrations and even conjugations would thus become logical, convenient explanations for reported pleomorphic data. Another extremist hypothesis of more than passing interest is the current suggestion that many highly parasitic micro-organisms have lost their primordial autonomy, and can now multiply only under the influence of certain extraneous plant hormones, equivalent zoological enzymes or other growth-stimulating factors.[3]

## II

If, as progressive bacteriologists allege, many bacilli can masquerade as pseudo-spirochetes or transmute into quasi-streptococci, if tuberculosis and gonorrhoea can disguise their infectious habits under new or altered staining reactions, and dysentery and typhoid fever pass hygienic filters as invisible micromidgets, then marked changes must be made in conventional clinical logics. It is apparently well confirmed that many of the "dwarf phases" of even the most hardy pathogenic bacteria do not grow, or grow only after prolonged "maturation" or "regeneration" periods when placed on routine culture media. Doubts are thus cast on many previously assumed sterilities of serums, bloods, organs, tissues, exudates and filtrates.

Special techniques are now being perfected to meet this clinical emergency, variants of the apparently inconstant Kendall's medium,[4] for example, and suggested reinforcements of routine culture media by the addition of bacteria-growth-stimulating plant hormones.[3] By one of these techniques, Miller[5] reports the successful test-tube cultivation for many generations of non-acid-fast midgets of the tubercle bacillus. Mellon's[6] description of his cultivatable *B. tuberculosis* dwarfs as non-acid-fast granules microscopically identical with the well-known diphtheroids of certain benign tumors is perhaps prophetic of pleomorphic data pathologists soon may be called upon to interpret.

[1] F. Löhnis, *Jour. Agric. Research*, 18, 675, 1916; Nat. Acad. Sci., 16, 1, 1921.

[2] P. Hadley, E. Delves and J. Klimik, *Jour. Infect. Dis.*, 48, 1, 1931.

[3] "Plant Hormones and Bacterial Growth," *J. A. M. A.*, 98, 1307, 1932.

[4] A. I. Kendall, Northwestern University Bulletin, 32, No. 8, 1931.

[5] F. R. Miller, SCIENCE, 74, 343, 1931.

[6] R. R. Mellon, Proc. Soc. Exper. Biol. and Med., 29, 206, 1931.

There is rapidly accumulating evidence that departures from classical test-tube morphology are almost invariably accompanied by equally marked changes in chemical composition. Whether this is due to the acquisition of new chemical specificities or to asymmetrical atrophies or hypertrophies of pre-existing specificities is still in doubt. "Chemovariation" also may occur without demonstrable morphological or tinctorial changes.

The clinical significance of such "chemomutations" arises from the qualitatively altered antigenicity or vaccination potential. Two test-tube "dissociates" of the same pure culture of *B. typhosus,* for example, might not be recognized as belonging to the same bacterial species by routine specific agglutination tests. Animals immunized against one *B. typhosus* "mutant" may show little or no demonstrable specific immunity against its sister "dissociate," nor will serums drawn from such immunized animals necessarily protect normal animals against the original "undissociated" culture. Many inadvertent "involution vaccines" have undoubtedly been used in the past.

"Chemomutations," "chemadaptations" or "chemodegenerations" may also take place on or within the infected animal body. The same filterable virus, for example, injected into two different animal species is reported to transmute into two different vaccination specificities.[7] The alternate generations of the spirochetes of relapsing fever have long been known to be of different immunological specificities, each wave of fever stimulating little or no specific immunity against the immediately preceding or immediately succeeding wave. Equally marked antigenic differences are now apparently well confirmed between primary and tertiary *T. pallidum.*[8] Staphylococci of different antigenicities have been isolated from different organs at the same human autopsy. Rosenow's[9] much-debated organotropic variants in focal infections are no longer isolated phenomena. Test-tube simulations of the "Rosenow variants" are currently reported by growing routine cultures of pneumococci and *T. pallidum,* for example, in certain organ-emulsions. These microbe-transmuting organ-emulsions contain organ-specific lipoids.[10]

## III

There is a growing tendency among progressive bacteriologists to picture the bacterial cell, not as a final indivisible infectious unit, but as an organized aggregate of vital colloids, or vital potentials, in much the same way that the animal body was divided about a century ago into an organized aggregate of histological units. Progressive bacteriologists allege that they must take this step, if they are to avoid postulating a supermaterial vital force or somatic spirit in the bacterial cell.

Apparently two distinct "morphons," or "vital colloids" are tentatively pictured in the bacterial cell.[11] The first, or "autonomous bion," is a single colloidal molecule, or "monomolecular amoeba," with a complete armament of crystalloid, hereditary genes and crystalloid, nutritional enzymes (see "Landsteiner phenomenon," section V). The second, or "nonautonomous bion," is a colloidal molecule deficient in one or more of the necessary hereditary or enzymic crystalloids. Such a "sub-bionic colloid" can show orderly synthetic increases in size and subsequent depolymerization into two or more daughter "sub-bions" only with the cooperation of intrabacillary hormones, enzymes or other integrating factors.

Bionic metaphors admittedly furnish convenient explanations for most of the alleged facts of the new dynamic microbiology. The "transmissible lysin" of Twort,[12] for example, may be pictured as a "non-autonomous bion" of no greater size or complexity than the ordinary protein molecule. This species-specific, non-autonomous colloid is incapable of self-proliferation, but proliferates or is proliferated in symbiosis with the homologous bacterial cell. Under certain conditions the resulting bion-bacterium-complex functions as a bacillus of exalted physiological functions.[13] *B. typhosus,* for example, homoplastically ingrafted with the corresponding Twort "sub-gonidial colloid," becomes the *B. typhi-hemolyticum* of recent nomenclature. This "hyper-gonidiate" has been repeatedly isolated from typhoid bloods and is regarded by certain radicals as the probable etiological factor of typhoid septicemia. The natural or artificially synthesized *B. typhi-hemoliticum* is alleged to breed true for several test-tube generations, but eventually to "dissociate," one of its "mutants" or "degenerates" being the primordial non-hemolytic saprophytic *B. typhosus* of routine laboratory study.

Under certain other conditions[14] the homoplastic ingrafted Twort sub-bion may overgrow and eventually dominate the 'phage-bacterium-complex. This dominance conceivably forces the transmutation of the bacillus into the filterable, dormant or free gonidial

[7] P. P. Laidlaw and G W.. Dunkin, *Jour. Comp. Path. and Therap.,* 41, 1, 209, 1928.

[8] "Artificial Neurotrophic Syphilis," *J. A. M. A.,* 96, 119, 1931.

[9] E. O. Jordan and I. S. Falk, "The Newer Knowledge of Bacteriology and Immunology," University of Chicago Press, Chap. 43, p. 576, 1928.

[10] "Organ-Specific Lipoids," *J. A. M. A.,* 97, 1628, 1931.

[11] J. Alexander, *Protoplasma,* 14, 296, 1931.

[12] "Limitations of Bacteriophage Therapy," *J. A. M. A.,* 96, 693, 1931.

[13] "Further Limitations of Bacteriophage Therapy," *J. A. M. A.,* 98, 1190, 1932.

[14] J. H. Northrop and A. P. Krueger, *Jour. Gen. Physiol.,* 15, 329, 1932.

phase, or causes autolysis, depending upon the ultimate interpretation of the word "lysis." Why a similar bionic overgrowth or resulting "lysis" does not take place with the "phage-resistant" *B. typhi-hemolyticum*, however, will necessitate further elaboration of the Alexandrian bionic metaphor.

Bionic metaphors are not wholly foreign to clinical medicine, though usually disguised in much more conventional nomenclature. During the last few years, for example, and in spite of prompt and heroic doses of diphtheria antitoxin, diphtheria has reasserted its ancient 25 per cent. mortality in Europe.[15] European clinicians, have not been forced to postulate an Asiatic importation of a superdiphtheria to account for this apparently new toxin specificity. Almost without exception they have turned to bionic hypertrophies, bionic metaplasias or Alexander's bionic modifications to account for the new specificity, forced bionic mutations conceivably due to the wide-spread use of the Schick test and diphtheria toxin immunization. A few visionaries have even gone further than this and have postulated a heteroplastic ingrafting of alien bions onto pre-war *B. diphtheriae*. This fantasy finds some support in the recently alleged artificial ingrafting of streptococcus bions onto the diphtheria bacillus to form "hybrid" or synthetic *B. strepto-diphtheriae*, which allegedly breed true for a dozen test-tube generations.[16] Bacterial-bionic symbiosis has also been postulated to explain the relationship of streptococcus to scarlet fever and of proteus X to certain animal diseases. The recent well-confirmed serological conjugation of virulent, type-specific pneumococcus bions with degenerated pneumococci with a resulting synthesis of a new type-specificity which breed true for innumerable test-tube generations,[17] is probably the most spectacular colloidal wizardry to which conservative bacteriologists are now trying to avoid applying the bionic metaphor.

## IV

During the last three years, there has been awakened interest in hitherto ignored biochemical identities or cross-reactions between pathogenic bacteria, environmental saprophytes and certain higher plant and animal tissues. The characteristic polysaccharide of the meningococcus, for example, is currently reported to be present in such apparently non-related bacteria as *B. anthracis*, *B. proteus*, *B. subtilis* and *B. mesentericus*.[18] Since the pneumococcus polysaccharides are known to function as successful fractional oral vaccines, cross-reactions of this type are not without suggestive clinical interest. Sub-antigenic (see: "Landsteiner phenomenon," section V) porphyrin compounds are allegedly present in numerous shellfish and in diphtheria toxin. The characteristic lipoid of certain strains of the Shiga bacillus is antigenically identical with a lipoid fraction of sheep erythrocytes and guinea-pig kidneys.[19] A *T. pallidum* lipoid is currently reported to be antigenically indistinguishable from the organ-specific lipoid of the human brain.[10]

A bacterial enzyme hydrolyzing one of the typed pneumococcus polysaccharides has recently been found by Avery and Dubos.[20] This enzyme not only decapsulates the corresponding type pneumococcus *in vitro*, but protects laboratory animals against multiple lethal doses of the homologous pneumococcus culture.

One of the extractable lipoids of the Shiga bacillus is antigenic for certain animal species,[18] but stimulates the production of no demonstrable antilipoid antibodies in other animal species. The Shiga antiserum from the second animal species is, therefore, deficient in an antilipoidal fraction conceivably needed by the first species. Physiological interchangeability of homologous antiserums was one of the basic tenets of the older immunology.

The anti-Shiga serum from the first animal species contains an antilipoidal factor not only superfluous for the second species, but potentially toxic for its tissues. Guinea-pigs, for example, injected intravenously with anti-Shiga rabbit serum may be killed in from two to four minutes with symptoms resembling acute anaphylactic shock. Accessory cytotoxins of this type have not yet been demonstrated in human medicine, although the clinical toxicity of certain discarded antiserums suggests similar relationships.[21]

Since *T. pallidum* allegedly contains a lipoid antigenically identical with a normal lipoid of the human brain, speculative immunology is beginning to wonder if convalescent immunity to syphilis may not be accompanied by the development of a human serum factor cytotoxic for human brain tissues. Such a conceivable but still unproved "immunological vicious circle" finds some support in the recently described "myalinolysin" in the serum of patients with multiple sclerosis. The injection of *B. welchii* toxin into a single bone marrow of a rabbit is reported to result in explosive degenerations of all bone marrows of its body, with a resulting circulatory deficiency resembling human pernicious anemia.[22]

[15] J. S. Anderson *et al.*, *Jour. Path. and Bact.*, 34, 667, 1931.

[16] "Upsetting Immunologic Tenets," *J. A. M. A.*, 96, 1232, 1931.

[17] J. L. Alloway, *Jour. Exper. Med.*, 55, 91, 1932.

[18] "Poliomyelitis Immunity," *J. A. M. A.*, 98, 1307, 1932.

[19] E. O. Jordan and I. S. Falk, *loc. cit.*, Chap. 53, p. 733, 1928.

[20] "Enzyme Therapy," *J. A. M. A.*, 91, 1540, 1931.

[21] "Serological Hazard," *J. A. M. A.*, 97, 710, 1931.

[22] J. C. Torrey and M. C. Kahn, *Amer. Jour Path.*, 5, 117, 1929.

## V

It is conceivable that future medical historians may regard the "Landsteiner phenomenon"[23] as the most important basic advance in infectious theory since the discovery of the phenomenon of anaphylaxis. Stripped of its chemical hieroglyphics, the Rockefeller Institute chemists demonstrated that conjugation of a relatively simple non-antigenic crystalloid with a specific protein often confers upon that protein a new immunological specificity. Injected into laboratory animals the protein-crystalloid-complex leads to the development of what may be described as a "duplex antiserum." One part or function of this antiserum is a crystalloid-specific "fractional antibody." With this "fraction" the crystalloid can be identified, either in its free state,[24] or when combined with a protein "carrier." The identification is allegedly made with the same ease and certainty with which *B. typhosus*, for example, can be differentiated from the colon bacillus.

It is, of course, too early to predict the numerous possible clinical applications of this new "duplex serology" or "crystalloid immunology." Any crystalloidal bacterial toxin, however, or any gastrointestinal putrefactive crystalloid that can be conjugated with or semi-permanently absorbed onto a protein "carrier," becomes a theoretically feasible antigen for attempted diagnostic and therapeutic research. Alkaloids and other non-colloidal pharmacodynamic agents may be conceivably studied by this conjugation technique, with specific immunizations of drug addicts and the serological verification of the basic tenets of homeopathy as legitimate research goals. A cancer-specific crystalloid[10] has already been reported, which can be raised to full fractional antigenicity by the Landsteiner conjugation technique, suggesting a future successful diagnostic test for malignancy.

Two facts of broad biological interest, however, are already well confirmed by the new crystalloid technique. First, a single crystalloid conjugated with animal, plant or microbic proteins may so completely dominate or homologize these proteins that they might readily be mistaken as belonging to the same biological group. Second, the fractional antigenic properties of a conjugated crystalloid depend, in part at least, on its type of union with the protein "carrier." Avery,[25] for example, found it necessary to guard against "burying" his sub-antigenic pneumococcus polysaccharide in the protein "carrier," if he wished to preserve its specific vaccination potential.

[23] "Non-protein Allergy," *J. A. M. A.*, 98, 1564, 1932.
[24] K. Landsteiner and J. van der Scheer, *Jour. Exper. Med.*, 54, 295, 1931.
[25] O. T. Avery and W. F. Goebel, *Jour. Exper. Med.*, 54, 437, 1931.

Facts of this type strongly suggest that future immunologists may find it advisable to recast the entire nomenclature of protein immunity and protein allergy in terms of unit sub-protein crystalloids. Certain European extremists are already postulating that the protein molecule in itself is nothing more than an immunologically inert colloidal "carrier" of superficial "determinants," "characteristics," "coefficients" or "quotients." This intuitively suggests that enzymes and heredity genes may be of no greater complexity than one of the Landsteiner crystalloids, a single protein molecule being the carrier of a score or more of unit hereditary, synthetic and lytic factors.[11] A single protein molecule thus becomes a conceivable "monomolecular amoeba" (see Alexander's "bions," section III).

## VI

One of the theoretical surprises of the past three years has been the fairly conclusive evidence that properties simulating specific serum "antibodies" appear apparently spontaneously in the circulating blood of both man and laboratory animals at the approach of sexual maturity.[26] Jungeblut and Engle, of Columbia University,[27] have been bold enough to apply this "pubescent immunity," "serological ripening," "maturation paniminity" or "phylogenetic recapitulation of ancestral immunity"[26] to a study of adult immunity to poliomyelitis. The sexually immature, poliomyelitis-susceptible monkeys of routine laboratory research were forced by them to a precocious maturity by ovarian transplants or by repeated injections with pituitary extract. Thus artificially ripened, the monkeys became insusceptible to routine intracerebral inoculations with poliomyelitis virus, and their serums neutralized poliomyelitis virus *in vitro*.

## VII

To those who have dreamed of the early test-tube syntheses of therapeutically useful "antibodies," the most discouraging surprise, however, is the recently alleged experimental evidence that there is a specific "immunity center" in the brain.[28] Without this "integrating center" specific somatic antibodies are alleged not to be formed in the body or liberated into the blood stream. Specific immunological conditioned reflexes are seriously proposed to account for certain specific immunological phenomena.

The mere suggestion of a conceivable "neurological integration" of specific antibody formation is so for-

[26] "Phylogenetic Immunologic Recapitulation," *J. A. M. A.*, 96, 775, 950, 1931.
[27] C. W. Jungeblut and E. T. Engle, *J. A. M. A.* (in press).
[28] "Tissue Autonomy and Antibody Formation," *J. A. M. A.*, 98, 484, 1932.

eign to the classical immunological autonomy of organs and tissues as to be almost insulting in its implications. One must admit, however, that this Ehrlich autonomy is not in harmony with modern theories of protein, carbohydrate and lipoid metabolism.

### SUMMARY AND CONCLUSIONS

The last three years of theoretical bacteriology and immunology have been characterized by four major movements:

(a) A tentative acceptance of a new dynamic concept of the infectious unit.

(b) A growing interest in the possible epidemiological importance of minor cross-reactions between pathogenic bacteria, environmental saprophytes and certain higher plant and animal tissues.

(c) An increasing skepticism of the classical belief that the protein molecule functions as a single antigenic unit.

(d) The beginning of serious interest in the basic genetic, enzymic, hormonal and neurological factors operative in specific immunity.

Professional bacteriologists and immunologists are divided into two schools in their acceptance or rejection of the newly suggested theories or plausibilities. The conservative school emphasizes the "intellectual recklessness"[29] that has led to futuristic theorizing before accumulation of absolutely conclusive experimental and observational evidence. The progressive school alleges that conservative theories are largely ancestral traditions, originally drawn from equally inconclusive data. If there is an element of truth in this allegation, the burden of proof rests equally on both schools.

Until the radical and conservative schools are harmonized, clinicians must apply the infectious logic of either school with an open mind,[30] depending for predictable clinical effects solely upon previous, adequately controlled clinical evidence.

# OBITUARY

## GEORGE KIMBALL BURGESS

ON July second, Dr. George K. Burgess, director of the National Bureau of Standards, was stricken with a cerebral hemorrhage while in his office at the bureau and died on the way to the hospital.

Dr. Burgess was born in Newton, Massachusetts, January 4, 1874, and was a direct descendant of Thomas Burgess, of England, who settled in Sandwich, Massachusetts, in 1638. He was educated in the public schools of Newton and later entered the Massachusetts Institute of Technology, where he graduated in 1896. Most graduate students of that period who were able to continue their studies abroad went either to Germany or England, but Burgess decided to study at the Sorbonne. This decision had a profound influence upon his later work. In Paris he became deeply interested in high temperature measurements under the guidance of Le Chatelier, and later translated Le Chatelier's book on this subject. Here he acquired a fluent use of the French language, which later was to prove of great service to him in important international conferences. Here also he met Mlle. Suzanne Babut, whom he married in 1902, and who survives him.

Following the award of his doctorate from the Sorbonne in 1901 with highest honors, Dr. Burgess joined the physics staff of the University of Michigan, and the following year was called to the University of California. In 1903 he entered the service of the Bureau of Standards, two years after its organization, and began a series of notable researches in the field of pyrometry, in large part in collaboration with Dr. C. W. Waidner. These investigations included an extended study of optical pyrometry, platinum resistance thermometry at high temperatures, the determination of the melting points of pure metals, and the study of the selective radiation from incandescent bodies.

It was during this period (1908) that Waidner and Burgess proposed as an absolute standard of brightness the radiation from the interior of a black body immersed in a bath of pure platinum at its freezing point. Lack of suitable refractories made it impossible to carry out the experimental procedure at that time, but twenty years later as director of the Bureau of Standards, Dr. Burgess had the keen satisfaction of seeing the Waidner-Burgess standard experimentally realized by members of the bureau staff.

His interest in the properties of materials at high temperatures led him into the field of physical metallurgy, and in 1913 he was made chief of the newly organized metallurgical division of the bureau. This marks the second stage of his career. He took up this work with characteristic energy and enthusiasm, and in the course of its development he demonstrated his marked ability as a technical executive. While directing this work, he still found time for his own researches on the causes of dangerous defects in railway materials. He demonstrated the practicability of measuring the temperature of steel rails as they pass

[29] H. Zinsser, SCIENCE, 75, 256, 1932.

[30] "Recommendations of the Allergic Research Council," *J. A. M. A.*, 94, 654, 1930.

through the rolls in the mill, which provides an important control as regards uniformity and quality. He also contributed to the development of an improved method for producing steel ingots from which sound rails could be rolled. His investigations have contributed materially to the safety of railway travel.

When Dr. Stratton closed his distinguished career at the bureau in 1923 by his decision to accept the presidency of the Massachusetts Institute of Technology, Dr. Burgess was appointed his successor as director of the Bureau of Standards. This selection met with the whole-hearted approval of the bureau staff. The progressive development of the work of the bureau during the past eight years under his direction bears witness to his wise administration. He was active in the development and final adoption of an international temperature scale and in support of the international program now under way to establish the electrical units in absolute measure. Through the research associate plan he developed industrial research at the bureau in cooperation with industry and technical organizations. During the last year of his administration the new national hydraulic laboratory was completed and extensive facilities were provided for the study of radio wave phenomena.

His office door was always open. Interruptions did not seem to worry him. His visitor found him dignified, but friendly, alert, attentive. He reached decisions promptly. His voice was low, his sentences crisp. His sense of humor was keen, and he responded to it with quiet body-shaking laughter. Sedentary in his habits, he had little interest in sports and games. Recreation to him meant a good book and a plentiful supply of tobacco, or a long drive in an open car with a friend. He loved the sea, and a long cruise was for him an ideal vacation.

Dr. Burgess gave generously of his time and energy to further the interests of organizations engaged in the advancement of research and standardization. At the time of his death he was president of the National Conference on Weights and Measures, chairman of the Federal Specifications Board, the National Screw Thread Commission and the Federal Fire Council, a director of the American Standards Association and a member of the National Advisory Committee for Aeronautics. His term of office as chairman of the National Research Council expired on June 30. He was a past-president of the American Society for Steel Treating, the Philosophical Society of Washington, the Washington Academy of Sciences, the American Society for Testing Materials and the Cosmos Club. He was a member of the National Academy of Sciences (past treasurer), the American Institute of Mining and Metallurgical Engineers, the Optical Society of America, the American Institute of Metals, the Physical Society of France, the Iron and Steel Institute of Great Britain and a fellow of the American Physical Society and the American Association for the Advancement of Science. Case and Lehigh had honored him with the degree of Doctor of Engineering.

His memory will be cherished by the staff of the organization to which he gave the greater part of his life, and by his numerous friends in scientific and industrial circles, not alone in America but throughout the world.

LYMAN J. BRIGGS

WASHINGTON, D. C.,
JULY 9, 1932

## MEMORIALS

THE centenary of the birth of Sir William Crookes occurred on June 17, and the issue of that date of the *Chemical News*, founded by him in 1859, is dedicated to his memory.

ON the evening of June 8 the graduating class of Duke University School of Medicine planted ivy, from Sir William Osler's home at Oxford, at the entrance to the medical school. At this ceremony Dr. William Sydney Thayer, of the Johns Hopkins Hospital, a former pupil of Osler, made the address.

THE members of the class of 1897 at Lehigh University recently presented to the university a portrait of Dr. Mansfield Merriman, Lehigh's first professor of civil engineering, who served continuously in this position from 1878 to 1907; and of Dr. Joseph Frederick Klein, the first professor of mechanical engineering, who served the university from 1881 to 1918.

THE collected papers of the late Professor J. U. Nef, first head of the department of chemistry in the University of Chicago, have been presented to the University of Chicago Library by his son, Dr. John U. Nef, of the department of economics in the same university. These papers consist of Nef's own reprints of practically all his published articles. Most of them appeared in *Liebig's Annalen*, the *Berichten der Deutsche Chemische Gesellschaft*, and the *American Chemical Journal*. In some cases, Nef made a very considerable number of corrections and comments in the margin, and these have all been included. This collection makes it possible, for the first time, to consult all Nef's works together, and to take account of the changes which he made in them during his lifetime. The articles run to a little more than 1,700 pages, and they have been bound together in three volumes. These may be consulted in the library of the department of chemistry, where they are to be kept permanently.

THE corporation of the Massachusetts Institute of Technology recently passed a resolution in tribute to the late George Eastman, who was a life member of the corporation. Mr. Eastman's gifts to the institute amounted to $20,696,053, which includes a contribution of $500,000 to the Technology Loan Fund, established to aid worthy students. President Compton stated that Mr. Eastman's contributions to various causes during his lifetime exceeded $112,000,000. The resolution expressed the corporation's "profound sorrow at the loss of its admired and beloved colleague, and deep appreciation of his outstanding qualities as a pioneer in business and applied science." The resolution, which was drawn up by President Compton and Francis R. Hart, also expressed the gratitude of the corporation for Mr. Eastman's very generous assistance in the upbuilding of the institute.

## RECENT DEATHS

FREDERICK HAYNES NEWELL, consulting engineer, formerly director of the U. S. Reclamation Service and later professor of civil engineering at the University of Illinois, died suddenly on July 5, at the age of seventy years.

DR. FRANK PELL UNDERHILL, professor of pharmacology and toxicology at Yale University School of Medicine, died on June 29, at the age of fifty-five years.

DR. JOSEPH LEIDY, physician, of Philadelphia, a nephew of Joseph Leidy, died on July 6 at the age of sixty-six years.

THE REVEREND DR. C. J. S. BETHUNE, the entomologist, died in Toronto on April 18, in his ninety-fourth year.

PROFESSOR NILS ERLAND NORDENSKIÖLD, the Swedish explorer, director of the ethnographic division of the Göteborg Museum, has died at the age of fifty-four years.

THE death is announced of Jean François Heymans, emeritus professor of therapeutics and pharmacodynamics at the University of Ghent.

DR. MITSUTARO SHIRAI, emeritus professor of plant pathology, University of Tokyo, College of Agriculture, died on May 30, aged seventy years. A correspondent writes: "Professor Shirai began his professional career as teacher of forest botany and plant pathology in this university in 1886. The earlier leadership in phytopathology began in Japan in the previous decade with the arrival from Germany of Professors Hilgendorf and his successor, Professor Ahlburg. These men were primarily lecturers on medical botany, but both included lectures on plant diseases. Following this in 1880 one of their Japanese students, S. Matsubara, gave the first regular course in plant pathology. Thus as an organized branch of botanical science, plant pathology may be considered at least as old in Japan as in the United States. Dr. Shirai in his later years had divided his attention between teratology and the history of botany in the Orient including plant pathology and plant culture in general."

# SCIENTIFIC EVENTS

## THE BRITISH NATIONAL PHYSICAL LABORATORY

THE annual inspection of the National Physical Laboratory at Teddington by the members of the General Board was held on June 28.

According to the report in the London *Times* in the aerodynamics department there were shown models of the engines of the Flying Scotsman and the Royal Scot expresses, which are being used to assess the air resistance of trains. The object of the experiments is to reduce the resistance by modifications to the form of the locomotive and the coaches, and secure economy in the consumption of fuel. The tests are now in progress, and the forces on the model engines and the coaches are being studied separately in the attempt to discover the ideal streamlined train. In the same department is the new compressed air tunnel which has been constructed for the examination of aircraft, and will enable tests to be made under conditions corresponding to those of a full-scale machine of average size flying at 150 miles an hour.

Recent experiments in the engineering department have included tests of ventilators for public vehicles. It has been found that with the use of long-distance coach services, the problem of ventilation has increased in importance. Various types of appliances have been submitted to the laboratory for inspection, and after numerous tests improvements have been suggested for the purpose of securing efficient ventilation without draught. Visitors to the engineering department will also gain information concerning experiments connected with wind pressures on buildings. It is pointed out that in the design of structures which are to be built on exposed sites allowance has to be made for the pressure of wind, and the modern tendency towards the erection of higher and wider buildings has added to the importance of this subject. The aid of the laboratory has been sought in this matter, and it is stated that, as a result of the experiments it has been shown how economy, as well as efficiency, may be secured in the erection of buildings. The department has also produced a set of safety de-

signs of lifting gear, such as crane swivels, chains, hooks, shackles, etc.

The physics department contains a section devoted to acoustics, and the building industry is taking increased advantage of the laboratory in regard to this subject. The designs of the new League of Nations Assembly Hall at Geneva were submitted for advice in respect of acoustical properties, and the laboratory has also been consulted regarding the acoustical features of the hall of the Permanent Court of International Justice at The Hague. A new building is now being added to the laboratory to increase the facilities for experiments. The uses of x-rays in the sphere of industry are explained in the department, where also examinations are made of radium for hospitals. It is stated that since the laboratory began this work radium of the value of £750,000 has been tested.

## LABORATORY FOR TROPICAL RESEARCH

THE *Bulletin* of the New York Zoological Society reports that the department of tropical research, under the direction of Dr. William Beebe, now has a substantial working laboratory, library and adequate storage facilities in the Zoological Park.

The collection of specimens obtained by Dr. Beebe and his staff during various expeditions has now reached such importance that in order to make this material readily accessible for careful study purposes a building in the Zoological Park has been remodeled and the department's collections installed. The laboratory, which is situated immediately south of the Aquatic Bird House, affords the necessary isolation essential to the carrying on of research work without interruption by visitors.

The building is a substantial one-story brick building with adequate daylight provisions and fully equipped with electric lights throughout. The main laboratory room is thirty-six feet long and twenty-six feet wide and is fitted with metal shelves and glass containers which make the specimens readily accessible for gross examination. The library and record room is twenty-five feet by sixteen feet and affords ample room for expansion. Two rooms about ten feet square are also available for laboratory and storage facilities.

The collections already installed in the new laboratory include all the specimens taken during the British Guiana, the *Noma, Arcturus,* Haitian and Bermuda Expeditions, as well as the paintings and drawings made during these expeditions.

During the past winter the staff has been engaged in the identification and study of the deep-sea specimens taken on the Bermuda and *Arcturus* Expeditions, and in the study of the shore fishes of Bermuda with a view to the preparation for publication of a "Handbook of the Shore Fishes of Bermuda" as well as other papers on the same group of fishes. Miss Hollister is continuing her research on the skeletal features of fishes by means of chemical clearing methods. Much of the work now being done in the laboratory consists of sorting and preparing for shipment to experts in other institutions many of the invertebrate specimens which have not as yet been described.

## MORTALITY STATISTICS IN THE UNITED STATES

THE Department of Commerce announces that in the United States death registration area in 1930 there were 1,343,356 deaths, with a rate of 1,133.1 per 100,000 population. Deaths and rate for 1929 were 1,386,363 and 1,191.9, respectively. These rates are based on estimated populations of 118,560,800 in 1930 and 116,317,515 in 1929.

The decrease in the mortality for the whole registration area of the United States is caused almost entirely by the great reduction in the number of deaths from influenza, from 64,853 in 1929 to 23,066 in 1930, for which respective rates were 55.5 and 19.5 per 100,000 population, and pneumonia (all forms) from 106,597 to 98,657 and rates from 91.6 to 83.2. Whooping-cough and diphtheria also decreased quite markedly, the former from 7,310 to 5,707 deaths and rates from 6.3 to 4.8, and the latter from 7,685 to 5,822 deaths, and rates from 6.6 to 4.9.

The only marked increases were caused by diseases of the heart, the number of deaths having increased from 245,244 in 1929 to 253,084 in 1930 and the death rate from 210.8 to 213.5 per 100,000 population, and cancer and other malignant tumors, deaths from 111,569 in 1929 to 115,265 in 1930 and the rate from 95.9 to 97.2.

Although the increase in the number of deaths from all accidental and external causes is not significant, these causes attract attention. Beginning with 1930, a dual method of classifying external causes of death has been employed, so that the number of deaths classified under burns, accidental drownings and accidental falls in the regular table are also included in the supplemental tabulation. The supplemental tabulation is made in order that comparable statistics may be had with the classification of earlier years. In the United States death registration area there were 625 burns, 809 drownings and 2,640 accidental falls, classified under certain kinds of accidents in the supplemental tabulation, which are also included in the regular table. The title "water transportation" is a new one, and 544 of the deaths classified under this title as due to drowning, in prior years were included under the title "accidental drowning"

only. In addition, of the 29,080 deaths from automobile accidents in 1930 shown in the supplemental tabulation; 280 burns, 227 drownings and 934 falls contribute to the total deaths from accidental and unspecified external causes and are also shown under their respective titles in the regular table.

## ITHACA MEETING OF THE AMERICAN PSYCHOLOGICAL ASSOCIATION

THE American Psychological Association will meet at Cornell University, Ithaca, New York, on September 8, 9 and 10, under the presidency of Professor Walter R. Miles.

Reservations of rooms can be made in the dormitories. The sessions will be held in Goldwin Smith Hall and there will be an exhibit of apparatus in the Library of Psychology in Morrill Hall. In addition to the presidential address on Friday evening and the round table on radio education on Friday afternoon, with Dr. Paul S. Achilles as chairman, the scientific program will be given in seventeen sections.

The chairmen of the sections and the number of papers are as follows:

General Papers, Walter R. Miles, seven papers.
Personality and Character, H. L. Hollingworth, eight papers.
Work and Efficiency, Walter Dill Scott, five papers.
Sensory Phenomena, Madison Bentley, seven papers.
Animal Psychology, Robert M. Yerkes, seven papers.
Clinical Psychology, James Burt Miner, five papers.
Child Psychology, John F. Dashiell, nine papers.
Sensory Phenomena, J. McKeen Cattell, eight papers.
Abnormal Psychology, Knight Dunlap, seven papers.
Animal Psychology, Harvey A. Carr, eight papers.
Clinical Psychology, Fred Kuhlmann, six papers.
Applied Psychology, Clark L. Hull, five papers.
Physiological Psychology, K. S. Lashley, eight papers.
Learning, Raymond Dodge, eight papers.
Mental Tests, Joseph Jastrow, four papers.
Memory, Arnold Gesell, nine papers.
Animal Psychology, Walter S. Hunter, seven papers.

## THE JOHN SCOTT AWARDS

THE John Scott awards, for inventions or discoveries of industry which "may add to the comfort, welfare and happiness of mankind," presented annually by the Board of City Trusts, Philadelphia, were presented recently, according to *The Christian Science Monitor,* to Dr. Joseph Slepian, Mr. George H. Emerson, Mr. Edward G. Budd and Mr. William Le Roy.

Dr. Slepian, consulting engineer of the Westinghouse Electric and Manufacturing Company, was cited for his work in connection with gases and fundamental inventions involving these discoveries, the application of which has resulted in the production of an apparatus for arresting lightning charges and other electrical discharges of extremely high voltage.

Mr. Emerson, of Baltimore, was honored for his invention of the water tube fire box, which makes for greater efficiency and longer useful existence of the engine. Engines equipped with this type of fire box are capable of much longer runs than those with the ordinary type. Runs of 300,000 miles without substantial fire box repairs are frequent, and there is also less tendency to explosion with this box.

Mr. Budd, of the Budd Manufacturing Company, of Philadelphia, received the award for his process of shot-welding stainless steel which makes possible the use of this material for railroad cars and airplanes. This material gives the necessary stiffness, with far less weight per passenger than has been realized in any railroad car heretofore built. Lighter trains result in a reduction in cost of construction and operation of the cars. A greater speed is also attained.

Mr. William Le Roy, of the General Electric Company, Schenectady, New York, was named for his development of the mercury boiler, which is capable of higher ranges of temperature than are practicable with steam in turbines.

Established in 1816, through a bequest by John Scott, a chemist of Edinburgh, Scotland, these awards consist of a bronze medal, a certificate and $1,000 each. The original fund amounted to only $4,000, and the cash awards were each $20. Increasing to what amounted to $100,000 in 1910, the fund now permits the increase in the awards.

# SCIENTIFIC NOTES AND NEWS

THE honorary degree of doctor of science has been conferred by the University of Cambridge on Sir William Bragg, director of the Royal Institution.

THE honorary degree of doctor of science was conferred by the University of Oxford, on June 22, on Sir John Russell, director of the Rothamsted Experimental Station, and on Dr. Willem de Sitter, professor of astronomy at the University of Leiden.

THE University of Rochester conferred at commencement the doctorate of science on Dr. Willis R. Whitney, vice-president of the General Electric Company, and on Dr. James Ewing, professor of pathology in the Cornell Medical School.

DR. CHARLES V. CHAPIN, superintendent of health at Providence from 1884 until his recent retirement, received the degree of doctor of science at the commencement exercises of Rhode Island State College.

MRS. ANNA JOHNSON PELL-WHEELER, of Prince-

ton, New Jersey, the mathematician, received the honorary degree of doctor of science at the commencement exercises of New Jersey College for Women at New Brunswick on June 4.

AT the commencement ceremonies honorary degrees were conferred by the University of Michigan on eleven alumni. These included an honorary doctorate of laws conferred on Dr. Douglas Houghton Campbell. The citation by, Professor John G. Winter, follows: "Douglas Houghton Campbell, a graduate in the class of 1882, doctor of philosophy in 1886, professor emeritus of botany at Leland Stanford University. His skill and proficiency in research have contributed greatly to American scholarship; his profound studies in the development and relationship of plants, notably of liverworts, ferns and mosses, have won for him recognition and honor from learned societies at home and abroad. A scientist whose microscope reveals the infinitely small to a mind whose vision extends to the broad horizons of the living world."

DR. FRANK T. SHUTT has been elected an honorary retired fellow of the Canadian Institute of Chemistry. The citation, signed by A. Cameron, president, and L. E. Westman, secretary, is as follows: "For forty-five years Frank T. Shutt has devoted his life to the advancement of chemistry in Canada. He has contributed, in a most outstanding manner, to the progress of agricultural science, and to our knowledge of soils, crop growth and the utilization of agricultural products. As Dominion chemist and assistant director, Experimental Farms, Ottawa, he has established facilities for research which have placed Canada in a position of prominence. It is the wish of this institute to acclaim the scientific merit and usefulness of his professional achievements."

*Nature* reports the election of associates of the Royal Astronomical Society as follows: Professor Giorgio Abetti, director of the Royal Astrophysical Observatory at Arcetri, Florence, who is known for his observations on the chromosphere and on solar prominences; Professor R. Emden, professor of physics, Technical High School, Munich, and author of "Gaskugeln" (1907), which consolidated and extended earlier work on the internal constitution of the stars, and has been the foundation of more recent work on this subject; M. Ernest Esclangon, director of the observatories at Paris and Meudon, who in addition to astronomical work has carried out a gravity survey in southwestern France; Professor H. Ludendorff, director of the Potsdam Observatory, and in 1920–30 secretary of the Astronomische Gesellschaft, distinguished for his work on stellar spectroscopy; Professor P. J. van Rhijn, director of the Kapteyn Astronomical Laboratory, Groningen, Holland, author of numerous papers on the proper motions and distribution of the stars.

DR. PETER H. BUCK (Te Rangi Hiroa), ethnologist on the staff of Bernice P. Bishop Museum, Honolulu, has been awarded the Hector bronze medal for his contributions to Maori ethnology. This medal is awarded annually by the Board of Governors of the New Zealand Institute for the outstanding contribution to botany, chemistry, ethnology, geology, physics (including mathematics and astronomy), or zoology, in New Zealand, the six sciences being considered in rotation. The medal carries with it the income from a fund established in memory of Sir James Hector, formerly president of the institute, which this year amounts to sixty pounds. Dr. Buck will be the Bishop Museum traveling professor in anthropology at Yale University this year.

DR. STEPHEN J. MAHER, chairman of the Connecticut Tuberculosis Commission, has been presented with the Laetare Medal, annually awarded by Notre Dame University "to the member of the Roman Catholic laity who has made the most outstanding achievement of merit during the year." The Reverend M. A. Mulcaire, vice-president of Notre Dame, presented the medal at ceremonies held on the lawn of Albertus Magnus College. Governor William L. Cross, of Connecticut, attended the ceremony.

THE Jacob F. Schoellkopf Gold Medal for 1932 has been awarded by the Western New York Section of the American Chemical Society to William Hale Charch, of the Du Pont Cellophane Company, because of his successful solution of the problem of moisture-proofing cellophane and for his contributions to the chemistry of cellulose.

THE Hillebrand prize of the Washington section of the American Chemical Society has been awarded to Dr. G. E. F. Lundell, of the Bureau of Standards, in recognition of the outstanding merit of his book on analytical chemistry.

DR. ARTHUR EDWIN KENNELLY, professor emeritus of electrical engineering at Harvard University, was elected on July 6 vice-president of the International Electrical Congress which is meeting in Paris.

THE officers of the Chicago Academy of Criminology for the coming year are: *President,* Dr. Edwin H. Sutherland, department of sociology, University of Chicago; *Vice-presidents,* Dr. Ludwig Hektoen, director, John McCormick Institute for Infectious Diseases; Dr. Paul L. Schroeder, director, Institute for Juvenile Research, and Dr. Arthur J. Todd, department of sociology, Northwestern University, and

*Secretary,* Dr. Meyer Solomon, department of neurology, Northwestern University Medical School.

DR. GEORGE PLIMPTON ADAMS, chairman of the department of philosophy at the University of California, will fill the Mills professorship of intellectual and moral philosophy, left vacant since the death of Professor George H. Howison in 1916.

DR. M. E. HOLMES, formerly head of the department of ceramic engineering in the School of Mines and Metallurgy in the University of Missouri, has been appointed head of the New York State College of Ceramics at Alfred University. The new building, erected at a cost of $175,000, is nearing completion. It includes the first college technological laboratory in glass in the United States. The building was provided for by the legislature in 1930. The state has provided $40,000 more for the purchase of furniture and laboratory equipment.

DR. PAUL H. M.-P. BRINTON, who has recently been engaged in chemical research at Pasadena, has been appointed to the chair of chemistry in the University of Southern California, vacant by the death of the late Wilfred W. Scott.

DR. WILLIAM C. ANDERSON, dean of the Brooklyn College of Pharmacy of Long Island University for the last twenty-eight years, has been appointed a member of the Board of Pharmacy of New York State. Dr. Anderson, who has been a member of the faculty of the Brooklyn college since its inception in 1891, is past-president of the House of Delegates of the American Pharmaceutical Association.

DR. WM. CHARLES WHITE has been appointed by President Hoover as delegate on the part of the United States to the eighth conference of the International Union against Tuberculosis which will be held at Amsterdam and The Hague from September 6 to 9, and has been designated chairman of the delegation. Dr. White sailed in July to deliver an address before the tuberculosis division of the centenary meeting of the British Medical Association on "The Influence of Robert Koch on Preventive Medicine."

THE United States Government having been invited through the British Embassy to participate in an International Congress on Prehistoric and Protohistoric Sciences, which will be held in London from August 1 to 6, the invitation has been accepted and the following anthropologists have been designated as delegates on the part of the United States: Dr. Herbert Joseph Spinden, chairman, curator of ethnology, Brooklyn Museum, Brooklyn, N. Y.; Dr. Roland Burrage Dixon, Peabody Museum, Harvard University; Dr. Carl Eugen Guthe, University of Michigan; Dr. Alfred Vincent Kidder, Carnegie Institution, Washington, D. C.; Dr. George Grant MacCurdy, Peabody Museum, Yale University, and Nels Christian Nelson, curator of prehistoric archeology, American Museum of Natural History.

DR. MARY LOUISE FOSTER, associate professor of chemistry in Smith College, is sailing shortly for Santiago, Chile, where she will spend a sabbatical leave of absence in equipping the laboratories of chemistry and physics in Santiago College. This college, founded in 1880 by Americans in Santiago, has recently received a large increase in endowment and a charter as junior college from the University of the State of New York. Dr. Foster will inaugurate the new courses in chemistry and physics.

*Nature* reports that Sir William Bragg, director of the Royal Institution, left England on June 25 for a lecture tour in South America under the auspices of the Ibero-American Institute of Great Britain, of which the Prince of Wales is president. Sir William planned to reach Buenos Aires on July 15 and leave there on August 1, when he expects to go to Rio de Janeiro. At both places he will be the guest of the British Ambassador and will deliver lectures on recent work on x-rays and crystal analysis. Sir William is expected back in England about August 29.

DUE to the unexpected inability of Professor G. Gamow to leave Leningrad this summer, his place in the Theoretical Symposium at the University of Michigan has been taken by Dr. Gregory Breit, professor of physics at New York University, who is lecturing on the quantum theory of radiation and dispersion.

THE thirty-eighth summer meeting of the American Mathematical Society, together with the sixteenth colloquium of the society, will be held at the University of California at Los Angeles, beginning on Tuesday, August 30. Dr. Earle R. Hedrick, past president of the society, is chairman of the committee on arrangements for the meeting. There has been planned a series of five colloquium lectures by Professor J. F. Ritt, of Columbia University. Professor D. N. Lehmer, of the University of California, and Professor Tibor Rado, of Ohio State University, will deliver addresses; Professor Lehmer's subject being, "The Continued Fraction Representing Cubic and Higher Irrationalities," and Professor Rado speaking on "Recent Work in the Problem of Plateau." Accommodations for members and their guests have been provided on the campus of the university. Provision has also been made for an excursion on Thursday afternoon for a visit to Mount Wilson Observatory, and to the various colleges and universities in Los Angeles and near-by cities.

BY the provisions of the economy bill recently passed by the Congress and signed by the President

on June 30, the Smithsonian Institution loses, through enforced retirement, a number of its staff, most of whom have served the Institution for many years. The list of those retired follows: Richard A. Allen, B. A. Bean, C. A. Carlsson, De Lancey Gill, W. H. Holmes, Lewis Jones, William Jones, W. H. Lanham, James S. Peyton, W. de C. Ravenel, Albert Strong, H. C. Taylor, J. G. Traylor (retired as appointment clerk), B. C. Tuckson, C. S. Washington and A. L. Young. The following who would have been retired under the provisions of this act have been continued by the President for various reasons: W. H. Blackburne, Frank H. Cole, J. N. B. Hewitt, Walter Hough, C. W. Shoemaker and Leonhard Stejneger. Owing to vacancies resulting from the enforced retirements, the following administrative changes have been made: R. P. Tolman has been appointed acting director of the National Gallery of Art. J. E. Graf is serving in the capacity of director of arts and industries. The division of fishes is under the direct charge of Dr. Leonhard Stejneger.

NATURE reports that the British Medical Research Council announces that, on behalf of the Rockefeller Foundation, it has made the following awards of traveling fellowships for the academic year 1932–33; these fellowships are awarded to graduates who have had some training in research work either in the primary sciences of medicine or in clinical medicine or surgery, and who are likely to profit by a period of work at a chosen center in America or, in special cases, in Europe, before taking up positions for higher teaching or research in the British Isles: Mr. C. P. Beattie, Bacteriology Department, University of Edinburgh; Mr. W. D. W. Brooks, St. Mary's Hospital, London; Dr. Eleanor M. Creak, Maudsley Hospital, London; Mr. I. G. W. Hill, Royal Infirmary, Edinburgh; Mr. W. A. Mackey, Department of Surgery, University of Glasgow; Mr. D. J. Macmyn, King's College Hospital, London; Dr. J. C. Moir, University College Hospital, London.

THE new legislature of Mississippi has enacted legislation creating a board of trustees in charge of higher education in the state. These trustees are now undertaking to repair the disaster caused two years ago by the then governor of the state by which more than 150 teachers in these institutions were dismissed. Chancellor Alfred Hume has been reinstated in the chancellorship. Professor D. H. Bishop has returned to the professorship of English and has been made vice-chancellor. Dr. A. L. Bondurant has returned as dean of the graduate school and Dr. J. N. Swan as head of the department of chemistry.

ATTORNEY GENERAL SCHRADER of Pennsylvania has ruled recently that there shall be a 24.16 per cent. reduction in appropriations to non-preferred institutions on account of reduced state income. He included the Pennsylvania State College on this list. The ruling applies to the total appropriation in the present biennium amounting to $4,000,000. Since the college has used approximately $2,000,000 or half the total appropriation, during the past year, it has only $1,000,000 coming from the state this year under the decision.

THE Shenandoah National Forest, lying approximately 100 miles southwest of the nation's capital in a region frequently traversed by the first president, has been renamed the George Washington National Forest. The Secretary of Agriculture, upon recommendation of Major R. Y. Stuart, chief of the forestry service, chose the forest as the most fitting to be named as a perpetual memorial to George Washington. It lies in Virginia and West Virginia and was in part surveyed by Washington. The George Washington National Forest stretches for nearly 100 miles along the summit and slopes of the Shenandoah Mountains and for a shorter distance along the Massanutten Range. Other existing national forests named for presidents are the Lincoln in New Mexico, the Cleveland in California and the Roosevelt in Colorado.

ACCORDING to the *Journal* of the American Medical Association, at the Victor Emanuel Library in Rome, a national bureau of bibliographical information has been established, the object of which is to furnish to Italian and foreign students such information as will aid in their research and to point out the libraries in which they can find the publications and manuscripts that interest them. The organization will also function as an intermediary organization for the exchange of information of a bibliographic nature. The Italian libraries are under obligation to comply with the requests for information submitted to them by the newly established center.

# DISCUSSION

## PRATT AND AIRY AND ISOSTASY

SCIENCE NEWS LETTER has done a real favor in reprinting the clear statements by Pratt and Airy of their respective theories as to the density and thickness of the earth's crust. Both of them were well worth considering at the time.

It may be well to call attention to some of their arguments in view of our present light. It will be noticed that Airy in discussing the fluid earth says it may be "little more than that degree of yielding which (as is well known to miners) shows itself by changes in the floors of subterraneous chambers."

On this, of course, much evidence has been gathered and there are deeper mines than in his day.

He refers to the crust lying on the lava as comparable to the "state of a raft of timber floating upon water; in which, if we remark one log whose upper surface floats much higher than the upper surfaces of the others we are certain that its lower surface lies deeper in the water than the lower surfaces of the others." This would, of course, be true of logs of the same material, say pine, but as I pointed out in a talk which I gave in Washington, if some of the logs were pine and others oak, we might have logs of pine projecting higher than those of the oak, while the bottoms were all at the same level, and this would be as Pratt pictures it.

Pratt does not agree with the hypothesis for the following reasons:

(1) That the hypothesis "supposes the thickness of the earth's solid crust to be considerably smaller than that assigned by the only satisfactory physical calculations made on the subject—those by Mr. Hopkins, of Cambridge. He considers the thickness to be about 800 or 1,000 miles at least."

We now know from the calculations of the seismologist that there is a much thinner crust than this.

(2) "It assumes that this thin crust is lighter than the fluid on which it is supposed to rest. But we should expect that in becoming solid from the fluid state, it would contract by loss of heat and become heavier."

But it is now generally accepted that there is a lighter layer, the thickness of which has been given by various recent writers from ten to fifty kilometers, but practically all recent writers, including Daly and Holmes, accept some such lighter layer.

(3) The third point that he makes is that if for every "protuberance outside this thin crust there must be a protuberance inside it would be equally true that wherever there was a hollow as in deep seas, in the outward surface, there must be one also in the inner surface of the crust corresponding to it."

This is the region which Meinesz has recently been investigating.

Finally, it will be noticed that Pratt assumes that "as the crust formed, and grew thicker, contractions and expansions may have taken place in any of its parts, so as to depress and elevate the corresponding portions of the surface." If then, he goes on to say, these changes "took place chiefly in a vertical direction, then at any epoch a vertical line drawn down to a sufficient depth from any place in the surface will pass through a mass of matter which has remained the same in amount all through these changes."

Obviously, this is not in harmony with the tremendous overthrusts which geologists are now finding, not to mention such ideas as continental drift.

ALFRED C. LANE
TUFTS COLLEGE

## THE DELUSIVENESS OF FILTERING COMPOUND SOUNDS

THE invention of electric filters to cut out of a compound current certain frequencies, while the others are but inconsiderably weakened, has opened the way for the convenient study of certain phenomena in the psychology of hearing. But caution is needed. Electric filters are not sensation filters.

The ambiguity of interpretation dates farther back than the few years ago when electric filters were put in practice. The old Ohm-Seebeck controversy of 1841, in *Poggendorff's Annalen*, will never die until experimental actuality triumphs over mathematical beauty. The highly musical Seebeck emphatically stated his observations that the fundamental tone of a compound is heard more strongly than it should be heard if the ear were a harmonic analyzer. The totally unmusical Ohm (he compares himself with the color blind) emphasized that, if the ear performed a Fourier analysis, it would *only moderately deviate* from Seebeck's experiments. The physical brotherhood has supported Ohm's rationalization until to-day.

In 1898, I published[1], among numerous other experimental facts, the following: A whistle tone "8" is made so weak, that while clearly audible alone, it is completely masked by a lower tone "5" of constant intensity and rather strong. "5" is now sounded first. At the moment when "8" is physically added, it is *not added* to the sensation; and clearly observable are now the physically *non-existing* tones "2" and "1." And yet we assert that the cochlea performs a Fourier analysis.

A few years ago the Bell Telephone Laboratories distributed a series of highly interesting filter records for the phonograph. I quote from "Record BTL-5-A, Vocal Tones, Illustrating the Recognition of Pitch." "This record is to show how *the ear supplies* tones actually not present. The sung vowel ah is heard with its fundamental eliminated. You notice a quality difference, but the pitch remains the same." Nevertheless, Dr. Fletcher[2] says: "The . . . *brain* may aid in making interpretations." Needless to say, no one has published any conception of a brain function adequately analyzing sound.

But there are dissenters. W. C. Beasley[3] experimentally attacked the stronghold of Ohm's defenders, the alleged irrelevance of phase shifts of the com-

[1] *Zeitschrift für Psychologie*, 16: p. 6. 1898.
[2] Harvey Fletcher, "Speech and Hearing," p. 122. 1929.
[3] *Jour. Gen'l. Psychol.*, 5: pp. 331, 347, 348. 1931.

ponents: *"No one* has demonstrated that phase *does not* influence quality of tone. Special apparatus permitted us a continuous change of phase with independent control of intensity and frequency. . . . For each cyclic phase shift, the sensation components vary in loudness. . . . The results are inconsistent with resonance analysis."

If filters could filter out "sensations," one could change a sung bass note into a soprano. G. O. Russell[4] tried it: "Filters cutting out frequencies below 500—but oddly enough, observers still do not hear it as changed to a feminine voice; yet the lowest physical frequency still present is well up in that range."

Let us repeat our warning. Electric filters do not filter out sensations. They physically destroy "Fourier Components." It is true, in ninety (or more) cases out of a hundred the sensations are also gone. But the exceptions, the sensations unexpectedly remaining, are of far greater importance for acoustical science, for they prove that *the cochlea, while being the analyzer, is not a Fourier analyzer*[5].

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## A SOURCE OF STUDY MATERIAL FOR THE COUNTRY MAMMALOGIST

WHILE engaged in an investigation on the food and feeding habits of New York fur-bearers during the past few years, the writer has come into contact with a number of trappers and fur buyers. Acquaintance with these men has made it possible to secure for study large numbers of the carcasses of skunk, weasel, mink, raccoon and fox.

Many of these fur buyers travel about their respective counties, buying furs, a good proportion of which are in the form of unskinned animals. These are brought to the buyers' headquarters, where they are skinned, and by previous arrangement with the writer the carcasses are saved. Trips are made every few days to these localities, the viscera removed, weights taken of unskinned animals and further notes made. During freezing weather, visits are made once a week. That a great deal of material can thus be secured is attested by the fact that one buyer of the writer's acquaintance handled over fifteen hundred skunks during the past season (1931–32) as well as many hundreds of other animals. Approximately one half of these were received in an unskinned condition and the bodies made available for study.

Suggested topics for study other than that of food are:

(1) Weights. Sexual and age variation, likewise loss or gain of weight during the fall and winter season.

(2) Reproductive Cycle. The rutting season may be determined in some forms; the period of appearance of first litters, etc.

(3) Hibernation. By keeping data on weather conditions, and noting the number of animals caught over a wide period of time, the influence of temperature and precipitation may be partly determined as influencing factors in the date of hibernation, also the appearance of the animals from a state of winter sleep. For example, it has been noticed in the case of skunks, that the females are seldom caught during the cold weather of December and January, while the males may be tolerably abundant.

(4) The dates of full primeness in fur bearers, with data on color changes, such as weasels.

(5) The ratio of the sexes; do the males or the females appear most numerous?

(6) Abnormal animals. While this perhaps is not as important as the others, the fur buyers and trappers are always willing to hold out unusual specimens for the student to examine. Considerable data on freak forms may be revealed in this manner.

It has been found that advertising for stomachs and writing trappers of one's wishes is of little value. It is possible to supply them with tags and crocks, containing a 10 per cent. solution of formaldehyde, in which they might drop the viscera after skinning the animals. While this is not as satisfactory a method as examining the entire carcass, it has the advantage of saving one numerous trips and much time. The data might be faulty on such specimens.

Such material carefully studied will give one a working basis on which to submit suggestions for changes in existing game laws, where these appear at present unfavorable to the animal's natural increase and perpetuation.

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## AMERICAN LINGUISTICS

IN SCIENCE of May 6, p. 491, Dr. Boas has noted that we may hope to learn most in regard to the history of American languages from a study of those stocks which have developed the greatest number of markedly distinct dialects. This has induced me to report briefly upon some of the results of my recent investigations of Cheyenne.

Cheyenne is a strongly divergent member of the Algonquian stock. It seems as if the transformation has been self-evolved and not due to extraneous influence. Thus, the number of even plausible Siouan loan-words is but a handful. On the other hand, I have a collection of more than seven hundred words and stems which are demonstrably Algonquian, even if these are but a fraction of the total vocabulary. It

[4] G. Oscar Russell, "Speech and Voice," p. 171. 1931.
[5] Max F. Meyer, "The Hydraulic Principles Governing the Function of the Cochlea." *Jour. Gen'l. Psychol.*, 1: pp. 239–265. 1928.

appears that the number of complex phonetic shifts, for the most part determined by adjacent sounds, is enormous. These involve the loss of consonants, at times of whole syllables, the transformations of consonants and vowels, the leveling of old vowel-quantities with a redistribution of such quantities, etc. To such an extent have these wrought havoc that words have been transformed almost beyond recognition. Who would suspect that maistō'ᵘ—"throat"—comes from *mekuntākɑni, ma'éxᵃ—"eye"—from *meckēncekwi, ho'ístᵃ—"fire"—from *ickutäwi? Yet it can be rigorously demonstrated. Incidentally the chronology of these shifts must be ever taken into consideration. Thus, the same Cheyenne sound may come from two distinct archetypes which have been merged, and in such cases the phonetic treatment often is determined by the original archetype. Another potent factor must also be reckoned with, namely, analogy. At times the plural of a noun has been influenced by the form of the singular, the reverse of what has happened in a few cases in Cree. The terms for bodily parts combined with possessive pronouns have frequently been rebuilt analogically. The so-called "intervocalic —t—" in verbal forms has been entirely wiped out. Thus it appears that the morphological transformations are due to phonetic shifts and analogy. I do not know a single Cheyenne morphological trait that is due to extraneous influence. The speech-form has remained Algonquian.

I am not in a position to report on Arapaho and Blackfoot, two divergent Algonquian languages, with any degree of confidence, save to say that I have worked out a number of phonetic shifts in both, with the result that the number of demonstrably Algonquian words has decidedly increased in both. This last applies especially to Blackfoot. Very fortunately in Cheyenne, Arapaho and Blackfoot the semantic transformations do not seem to be very radical. In conclusion it may be said that none of the above-mentioned languages contributes much towards the reconstruction of the parent Algonquian language, of which the historical languages are the descendants. An exception must be made in one or two cases where Cheyenne, though aberrant, is clearly archaic.

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## IRON TOXICITY FROM LIMING

IT has been found that one of the immediate effects of heavy liming rather acid soils with calcium carbonate is to greatly increase the iron content in the soil solution. Incident to liming the amount of organic matter in solution is greatly enhanced. Owing to the great increase in carbon dioxide in the soil, directly and indirectly the result of liming, the pH of the soil solution is maintained at a lower level until the excess carbon dioxide is largely dissipated. The first reactions in the soil are favorable for the holding of iron in the soil solution. As soon as the limed acid-soil comes to equilibrium the iron level falls back to a desirable amount for crop production. The adjustment period under field conditions would depend upon the weather, varying from several months to a year. This transitory higher level of iron in the soil solution, and perhaps other sesquioxides, apparently accounts for the toxic effects to farm crops from the use of large amounts of lime on some of the acid soils. In a case of the Caddo silt loam the use of a large amount of lime increased the iron content in the soil solution from 0.5 ppm to 50.0 ppm. The original reaction of the soil is pH 4.8.

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# SCIENTIFIC BOOKS

*Manual of Meteorology, Volume IV, Meteorological Calculus: Pressure and Wind.* By SIR NAPIER SHAW, with the assistance of ELAINE AUSTIN. Pages XX, 359, xii, and 79 illustrations. Cambridge: At the University Press. New York: The Macmillan Co., 1931, $9.50.

THIS last volume of Sir Napier Shaw's great "Manual of Meteorology" is not a book to be read at a single sitting. There are 600 words, or more, to the page and many sections are so full of thought and suggestions as to require reading and rereading with much pondering and meditation. This never is owing to carelessness in expression, for Sir Napier is a master in saying things both clearly and elegantly, but to the inherent difficulty of the subject itself, and the necessity for some sort of limitation to the length of the exposition.

No other treatise on meteorology approaches in magnitude this four-volume manual, and yet apart from the historical and statistical portions, it essentially is restricted to the mechanics and thermodynamics of the atmosphere. It would be a great boon if Sir Napier would give us a supplementary volume or two on the acoustical, electrical and optical phenomena that also pertain to that medium. This further contribution from him we wish, but have not the face to request. The task he already has accomplished was Herculean, and he richly deserves all the holidays he wants. But will he rest? Certainly not, if we may judge the future by the past.

The first chapter of this Volume IV treats of the laws of atmospheric motion, and a lot of things incidental thereto. Indeed, it is an excellent summary of a considerable portion of classical physics—harking back to the era of sanity when he studied under Helmholtz and taught at Cambridge. It is in this chapter that, like Rücker in 1889 (*Phil. Mag.*, Vol. 27, p. 105), he finds for absolute temperature the same dimensions as those of kinetic energy per unit mass. In this connection the reviewer regrets that Sir Napier passed by an excellent opportunity to say another good word for entropy which he has so effectively and abundantly used in his discussions of the atmosphere and its motions. He might have, as did Tolman (*Phys. Rev.*, Vol. 9, p. 247, 1917), regarded entropy as a fundamental quantity and from the expression $T=\frac{dQ}{dS}$ found for absolute temperature the dimensional value $ML^2T^{-2}S^{-1}$, that is, energy divided by entropy. This is very interesting, but no doubt most of us, in practice at least, shall continue using temperature in our equations and calculations as just a number on a scale, wholly without dimensions of any kind.

The second chapter, covering 50 pages, shows ways of applying mathematics to the problem of the movement of a parcel of air over the rotating earth, when subject jointly to the urge of an active push and the restraint of viscosity and turbulence. Here Sir Napier makes some portions delightfully easy, while others he leaves to the reader's own ingenuity and amusement. The rest of the book affords relatively easy and sure going, except, of course, over the many parts where knowledge of the way still is seriously deficient.

The next seven chapters give detailed accounts of the phenomena to which the mathematics of the second chapter apply, with numerous interesting and profitable side excursions. Sir Napier knows too much of his subject to be content to follow a straight and narrow course from premise to conclusion, nor are his readers willing that with such knowledge he should do so.

To the American readers of these chapters, in which a number of striking numerical values are given, a note of warning is in order. Sir Napier always uses the full-weight ton of 2,240 pounds, not our short-weight ton of 2,000 pounds. Again, when he says billion he means a sure-to-goodness British billion of a million million, and not our diminutive billion of only a thousand million.

The last chapter in this, the final volume of Sir Napier's great manual, is an appropriate and excellent retrospect over the whole present field of meteorology, in which he himself has been a most industrious and efficient worker—a retrospect, however, that closes with a stimulating urge to further good work in the future.

And now another warning: Don't think that when the excellent eleven-page index is reached the book is done, for after that, instead of the customary blank leaves, is a two-page postscript worth reading; and even after that, in turn, a convenient summary of the contents of the entire manual.

Now that this great work is available to all it might be supposed that the meteorological millennium at last had come, but it has not come, and it will not have come until the upper personnel, save only the business element, of every considerable meteorological service have fully mastered it and at least the dozen next best treatises on the air and its ways; nor, further, until they themselves, and those in line to follow them, have become creative workers in this same limitless field. All must agree that such a state of affairs is urgently needed. Furthermore, it is entirely possible to effect and, moreover, rapidly coming to pass.

W. J. HUMPHREYS

*My Nature Nook.* By W. S. BLATCHLEY. Pages 1–302, and 15 half-tone plates. The Nature Publishing Company, Indianapolis, 1931.

IN January, 1913, Dr. Blatchley went to the Gulf Coast of Florida from the rigors of an Indiana winter to find a place where he might spend a few months each year living an outdoor life in pleasant surroundings. He wished a place where he might be surrounded by a fauna and flora yet primitive and undefiled, where he might live in close daily contact with interesting trees and shrubs and the shy live folk that dwell among them. He selected Dunedin-on-the-Gulf, some twenty miles north of St. Petersburg, and has been going there each winter since. A short distance from the little town he found a secluded spot near Clearwater Bay and there he purchased a few square rods of land which he calls "My Nature Nook." He built a comfortable small house in which to live when bad weather makes it necessary to stay indoors. He then began seriously and with enthusiasm to examine the little patch of ground which was the first primitive spot of mother earth which he ever had that he could call his very own. He studied it in great detail, vastly more minutely than did Gilbert White the region which he made famous in that classic, "The Natural History of Selborne." Blatchley selected an old leaning oak tree, in a fork of which he made a comfortable rustic seat where he could sit, observe and think and write. And what he thought is duly set down in this book.

Blatchley is an old-time naturalist, a real naturalist in the broadest and best sense, as were Gilbert White, Rafinesque, Darwin, Agassiz, Audubon, Coulter and David Starr Jordan. They knew animate and inanimate nature as they saw her in the open. And so it was that Blatchley, being a naturalist and a philosopher, wrote so interestingly about the animals and plants which he saw in his Nature Nook near Dunedin. He tells the story in the form of a diary, in which he records from day to day his observations, his interpretation of their meaning and his philosophizing about the relations of plants and the lowly animals and human beings. The three hundred pages of this book are filled with fascinating accounts of the interesting habits of many of the animals and plants of the region.

Dr. Blatchley is primarily an entomologist, but he is more than that; he is also an excellent botanist and knows not a little about birds, mammals, reptiles and shells. His style as a writer is delightful, reminding one of Thoreau and Bradford Torrey. "My Nature Nook" is one of the most fascinating of recent nature books and should have a large sale.

BARTON WARREN EVERMANN

# SCIENTIFIC APPARATUS AND LABORATORY METHODS

## AN APPARATUS FOR COUNTING SAND GRAINS

THE counting of sand grains is destined to play an important part in the analysis of sediments. In the past grain counting has always been done with the naked eye or under the microscope, but either of these methods requires much time and patience. The following apparatus, based on principles used in seed-counting devices, was designed to afford a quick and accurate method of counting rock particles.

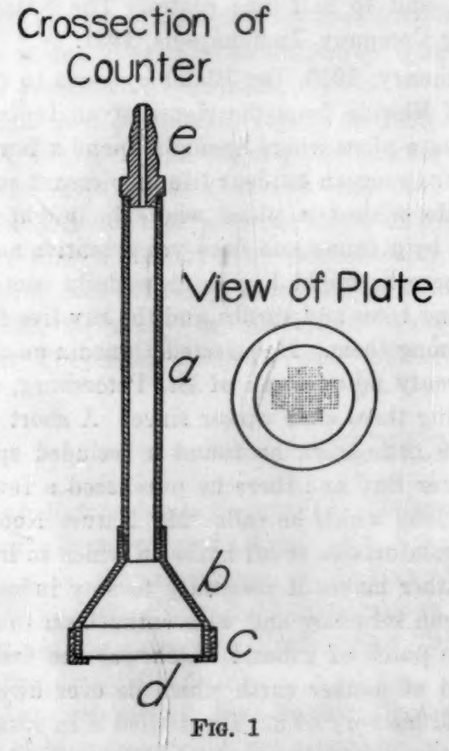


FIG. 1

The apparatus consists of a brass tube, a, having an inside diameter of ½" (1.27 cm). A small brass nozzle, e, is screwed in one end to facilitate the attachment of a rubber hose. At the other end is a funnel shaped brass cup, b. A clamping ring, c, fits onto this cup and clamps a thin brass plate, d, to it. This brass plate contains a definite number of small holes which must have smaller diameters than those of the particles to be counted.

A rubber hose is connected to e and attached to a filter pump or other suitable suction apparatus. The instrument is then ready for use. When the plate is brought in contact with dry sand grains whose intermediate diameters are larger than those of the holes in the plate, a single grain is attracted to each hole and held there by suction. In practise this suction must be regulated so that it is not too strong, otherwise a miniature mound of sand will be held to the plate. It has also been found necessary to blow gently over the face of the plate or to use a small brush and needle to distribute the grains evenly. A few of the holes will hold more than one grain, and a few will not hold any, but holes that do not hold grains are balanced by those holding more than one, so that the resulting maximum error averages less than 2 per cent. for the count. With careful manipulation of small brush and needle even this error can be eliminated. A 300-hole plate drilled with a No. 80 twist drill (about .333 mm) gives satisfactory results for the .50–.35 mm grade size.

The following table shows the results obtainable with the above-mentioned type of plate. The time required to count 10,000 grains was about an hour.

| Kind of fragments | No. by 300 grain capacity plate | Weight of 300 grains | Weight of 3,000 grs. by counter | Computed weight of 3,000 grs. | Difference | Per cent. of error. |
|---|---|---|---|---|---|---|
| Oolitic sd. ..... | 301 | .0505 g. | .4910 g. | .505 g. | .014 g. | 2.8 |
| St. Peter sandstone.. | 302 | .0345 g. | .3441 g. | .345 g. | .001 g. | .03 |
| Beach sd. ..... | 304 | .0310 g. | .3009 g. | .310 g. | .009 g. | 2.5 |

The seemingly large percentage of error for the oolitic sand is not due to lack of efficiency of the instrument, but to the range in specific gravity of the oolites. The error for the beach sand is due to the heterogeneous character of the material both in respect to shape and specific gravity of the particles.

This apparatus enables a rapid, accurate method of counting sand grains. The limiting factor is the size of the holes that can be drilled. The smallest drill I have been able to obtain has been a .004″ (.10 mm) jeweler's drill, which is extremely delicate and breaks easily. A small 25-hole plate made with this size drill worked well for the ⅛ mm grade size. A larger plate has not yet been attempted. For grains larger than ½ mm the punched brass plate made by the Harrington and King Perforating Co., Chicago, worked satisfactorily. Smaller diameter holes must be drilled by hand, or may possibly be made by means of the x-ray.

Although this instrument was made for counting sand grains, it can be applied for counting small particles of other types.

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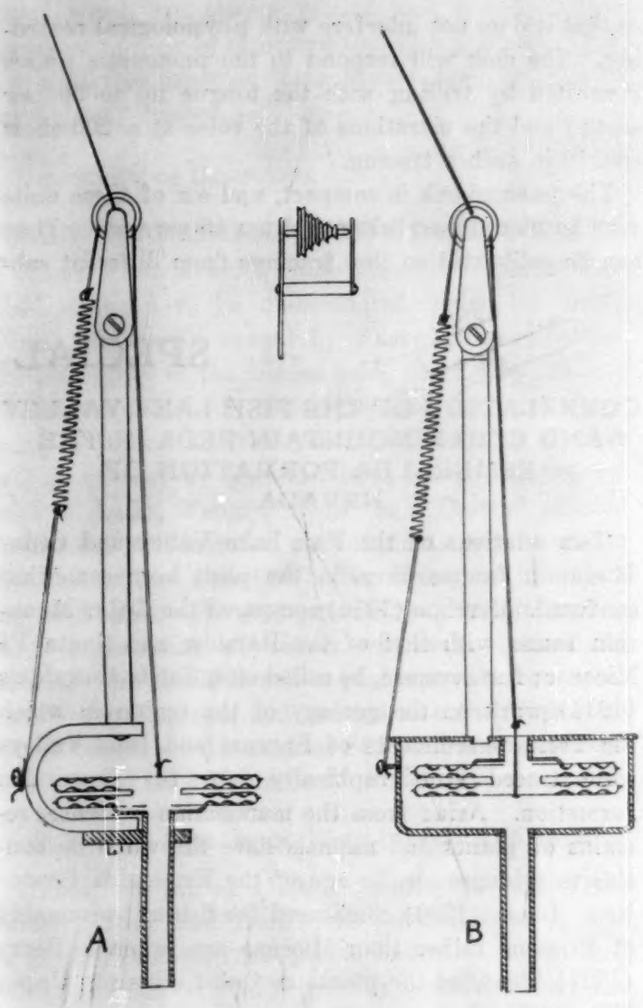
## A UNIT FOR KYMOGRAPH RECORDING[1]

THE rubber membrane of the Marey tambour is the unsatisfactory feature of the usual method of pneumatic recording. If it is delicate it must be replaced frequently and it is difficult to calibrate if calibration is important.

This pneumodeik (Fig. A) replaces the Marey tambour. The essential part of this recording unit is a quadruple, corrugated, very thin phosphor-bronze diaphragm, 4 cm in diameter, such as is used for airplane instruments. The diaphragm is attached to a horizontal rod at the end of which an aluminum pulley-cone is mounted on needle-point bearings. A light silk thread is fastened to the front disc of the diaphragm, passed round one of the pulleys and brought back on the other side of the rod where it is fastened to a delicate steel spring, the tension of which can be regulated by a thumbscrew attached to the mounting. A thin stylus of bamboo is glued to the broader base of the pulley-cone and tipped with a glass filament or a tiny bit of photographic film. The deik can be constructed at a cost of from 10 to 12 dollars.

The rubber tube conveying the pneumatic impulse is attached to a metal tube leading directly to the diaphragm. When the diaphragm is displaced by the air pulses, the thread rotates the pulley-cone; the diameter of the pulley selected and the length of the stylus determine the amplification. As the pulley can be made to slide easily under the thread, it is possible to shift the position of the stylus while it is writing on the drum. The writing stylus may be replaced by a small mirror and a beam of light recording on a moving photographic strip.




A useful modification of the pneumodeik (Fig. B) responds to changes in negative pressure. Muscular contraction can be conveniently recorded by applying to the surface over the muscle a light celluloid cup two or three cm in diameter with a light rubber tube leading to the deik. A simple aspirator connected by a Y-tube holds the cup in position by a negative pressure of c. 30 cm of water. No other attachment to the moving limb is necessary. Variations in the negative pressure caused by the bulging of the surface are easily recorded by the deik and furnish an accurate tracing of the muscular contraction at all speeds of movement.

The inertia of the moving parts of the deik is small, the system is under slight tension, and the rate of transmission is approximately that of a low sound wave. Tests show that the lag is less than .01 second, which is below the limit of error for ordinary kymographic work. The natural frequency of such a system is from 50 to 75 per second and is well damped

[1] Acknowledgments are due to Mr. B. J. Smyth, the Oberlin mechanician, who worked out the details of the design.

so that it does not interfere with physiological recording. The deik will respond to the pneumatic pulses generated by trilling with the tongue up to 30 per second and the vibrations of the voice at c. 200 show clearly in such a tracing.

The pneumodeik is compact, and six of these units may be placed parallel on a drum 15 cm wide. They can be calibrated so that tracings from different subjects and at different times may be compared. This is important in phonetics, for example, where the actual air pressures and the actual extent of minute movements are significant.

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# SPECIAL ARTICLES

## CORRELATION OF THE FISH LAKE VALLEY AND CEDAR MOUNTAIN BEDS IN THE ESMERALDA FORMATION OF NEVADA

THE relations of the Fish Lake Valley and Cedar Mountain faunas have, in the past, been somewhat confused. Merriam (1916) compared the Cedar Mountain fauna with that of the Barstow and Santa Fé Miocene; furthermore, he called attention to Buwalda's (1914) work on the geology of the region in which the Tertiary sediments of Stewart and Ione Valleys were traced stratigraphically into the Esmeralda formation. Aside from the mammalian evidence, remains of plants and animals have thrown little conclusive evidence on the age of the Esmeralda formation. Lucas (1900) considered the fish as presumably of Pliocene rather than Miocene age, whereas Berry (1927) identified the plants as "most certainly Upper Miocene."

The results of a University of California expedition to Cedar Mountain in 1925 yielded sufficient material for a much better identification of the mammalian fauna. The available evidence seems to justify the assumption that both Miocene and Pliocene epochs are represented. While the fossil material is not as complete nor the fauna as extensive as might be desired for correlation purposes, certain distinctions are apparent.

Evidence for the existence of two faunas in the Cedar Mountain Tertiary deposits is most clearly shown by the horse teeth. There are also certain differences in the preservation of the material from these two faunal assemblages. The *Merychippus* teeth from U. C. Loc. No. 2027 and especially the associated bony elements are heavily water worn, harder and more silicified than the softer and lighter colored specimens from the lacustrine deposits discussed by Buwalda (1914). *Merychippus, Pliohippus* and *Hipparion* teeth are present from localities in Stewart Valley, but in no instance has *Merychippus* been found in association with *Pliohippus* or *Hipparion*. The teeth of *Pliohippus* and *Hipparion* represent advanced types; therefore it is difficult to conceive of their being contemporaneous with *Merychippus*. The Miocene anchitherine horse *Hypohippus* near *osborni* from U. C. Loc. 2027 is smaller and distinct from the larger *H. nevadensis* from the lacustrine beds.

The Carnivora from the Middle Miocene locality are more primitive than most Pliocene genera. *Tephrocyon* near *kelloggi*, although represented by fragmentary material, is characteristically different from the customary Pliocene aelurodons.

Among the Artiodactyla, *Procamelus gracilis*[1] is found in the Fish Lake Valley beds and in the lacustrine deposits at Cedar Mountain. The identity of this material from both beds is one of the best indications of their contemporaneity.

The fossil beavers from Loc. 2027 are more primitive than *Eucastor tortus* from Fish Lake Valley and compare favorably with remains from the Santa Fé and Coalinga Miocene deposits. A description and discussion of these species will be made in a paper on the fossil Castoridae.

There is one species which is reported both in the Fish Lake Valley Pliocene and the Cedar Mountain Miocene fauna. Hall (1929) referred a series of edentulous lower jaws from locality 2027 to *Meteriz latidens*, a Fish Lake Valley species. It is questionable whether the lower jaws from Cedar Mountain belong to *M. latidens*, since no teeth are present to afford characters for comparison. When teeth are found from the Cedar Mountain Miocene deposits they will probably represent a new species.

The Miocene deposit, U. C. Loc. No. 2027, in the Cedar Mountain beds may be described as a lense of rewashed materials. The fossil mammal remains were found in a small area of brown sandstone lying in the fourth gully south of where the old road branches, one branch going to Stewart Spring (see Buwalda's map opposite p. 338, 1914).

The Fish Lake Valley fauna is predominantly Lower Pliocene and equivalent to the Upper Snake Creek and Valentine of Nebraska, also, the Little White River of South Dakota. The species do not compare closely with those from Thousand Creek or Rattlesnake. There are, possibly, some relations with

[1] The species *Procamelus cortatus* described by Stirton (1929) is probably conspecific with *P. gracilis* Leidy.

the Ricardo, but these are not clear. A comparison of the Fish Lake Valley and late Cedar Mountain fauna is unsatisfactory because of the lack of material from Cedar Mountain; however, identifiable specimens which are closely related and found in both localities appear to represent the same species. From the available evidence these faunas are the same or very closely related.

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FAUNAL LISTS

| Cedar Mountain | | Fish Lake Valley |
|---|---|---|
| Middle Miocene | Lower Pliocene | Lower Pliocene |
| | BIRDS | BIRDS |
| | *Nettion carolinense* (Gmelin) | *Branta esmeralda* Burt |
| | *Marila collaris* (Donovan) near *Querquedula cyanoptera* (Vieillot) ? | |
| MAMMALS | MAMMALS | MAMMALS |
| *Meterix* cf. *latidens* Hall | | *Meterix latidens* Hall |
| *Bassariscus parvus* Hall | | *Metechinus nevadensis* Matthew |
| | | *Mystipterus vespertilio* Hall |
| *Tephrocyon* near *kelloggi* Merriam | ?Aelurodon | *Aelurodon haydeni* (Leidy) |
| | | *Hypolagus* cf. *vetus* L. Kellogg |
| | | *Sylvilagus*? |
| New genus (Castoridae) | | *Eucastor tortus* Leidy |
| *Mylagaulus* sp. | | *Mylagaulus* sp. |
| | | *Entoptychus*? |
| | | *Diprionomys magnus* L. Kellogg |
| *Meniscomys* | | *Diprionomys parvus* L. Kellogg |
| | | *Diprionomys quartus* Hall |
| | | *Diprionomys tertius* Hall |
| | | *Macrognathomys nanus* Hall |
| | | *Peromyscus dentalis* Hall |
| *Hypohippus* near *osborni* Gidley | *Hypohippus nevadensis* | *Hypohippus* near *nevadensis* Merriam |
| *Merychippus* cf. *isonensus* (Cope) | *Pliohippus* cf. *leidyanus* Osborn | *Pliohippus* cf. *leidyanus* Osborn |
| | *Hipparion* cf. *occidentalis* Leidy | *Hipparion* cf. *occidentalis* Leidy |
| | | *Prosthennops* cf. *crassigenis* Gidley |
| | *Procamelus gracilis* Leidy | *Procamelus gracilis* Leidy |
| | | *Procamelus* cf. *robustus* Leidy |
| | | *Alticamelus* cf. *priscus* Matthew |

## SEED TRANSMISSION OF COTTON WILT[1]

MANY Fusaria which cause diseases of plants have been assumed to be disseminated inside the seeds. With cotton wilt, caused by *Fusarium vasinfectum*, the possibility of the disease being carried by the seed has been questioned. Gilbert[2] stated that "tests covering a period of four years to determine whether wilt is carried by the seed have given negative results." Later, Fahmy,[3] Neal[4] and Dastur[5] planted seed from wilt-infected cotton plants with negative results, and also failed to isolate Fusarium in culturing such seeds. The only previous evidence indicating seed transmission of cotton wilt was obtained by Elliott.[6] He obtained wilt in plants grown from seeds from infected plants and showed also that Fusarium spores placed on the exterior of cotton seed remained viable for at least 5 months.

### PLANTING SEED FROM WILT-INFECTED PLANTS

During the fall of 1929, a quantity of seed of the variety "Half and Half" was selected from a field in Brazos County, from plants known to be infected with Fusarium wilt as proved by isolations from the roots and stems. These seed were stored in the laboratory at room temperature and in 1930 divided in two lots. The seed of one lot were planted in a series of 40 cylinders, each 18 inches in diameter and 24 inches deep. These were sunk in the ground, closed at the bottoms by tight galvanized iron plates and filled with sifted Norfolk fine sandy loam soil material from an elevated, uncleared wooded section in Brazos County, known to have been uncultivated for at least 50 years. Untreated seed from the wilt-infected cotton plants were planted in wilt-free soil in 20 cylinders and seed delinted with sulphuric acid and then surface sterilized with 1:1000 mercuric chloride solution were planted in 20 more cylinders. Plants in 2

[1] Published with the approval of the director as Contribution No. 209, Technical Series, of the Texas Agricultural Experiment Station.

[2] W. W. Gilbert, "Cotton Wilt and Root Knot," U. S. Dept. of Agr., *Farmers' Bull.*, 625, 1914.

[3] Tewfik Fahmy, "The Fusarium Disease of Cotton (Wilt) and Its Control," Ministry of Agr., Egypt. Tech. and Sci. Series, *Bull.* 74, 1927.

[4] D. C. Neal, "Cotton Diseases in Mississippi and Their Control," *Miss. Agr. Exp. Sta. Bull.*, 248, 1928.

[5] J. F. Dastur, "Cotton Wilt," Memoirs of the Dept. of Agr. in India, Botanical Section, 17: 29–73, 1929.

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of the cylinders of each lot developed typical Fusarium wilt, which attacked 3.3 per cent. of the total of 667 plants. On the other hand, not a single plant developed wilt in the 723 plants which grew from seeds from normal plants of the "Gorham Lonestar" variety, planted in the same soil in 40 adjoining cylinders as checks.

Seed were planted also in large wooden boxes, each 5 feet wide and 15 feet long, and filled with soil material similar to that used for the cylinders. One box was planted with untreated seed from wilt-infected plants and another with the delinted seed. Typical wilt appeared in both boxes. Of 644 plants, 2.2 per cent. developed Fusarium wilt. The third box was planted with seed from normal plants, and not a single case of wilt appeared with the 238 plants.

Fusarium was recovered from all the wilted plants in the cylinders and boxes, and successfully reinoculated on cotton seedling grown in pots of steam-sterilized soil. Identification of the Fusaria isolated as *F. vasinfectum* was confirmed by Dr. C. D. Sherbakoff.

### Isolation of Fusarium vasinfectum from Wilt-infected Cotton Plants

This work was carried on in 1929 and 1930 with wilt-infected cotton plants selected from a field near Edge, Brazos County, and in 1931 with plants selected in a wilt-infested plat at College Station, Texas. The plants were secured during early fall as soon as the bolls were matured and opened, and seeds from them were cultured the following spring and summer. Before culturing the seeds, tissue cultures were made with parts of the tap-roots, stems and peduncles, to ascertain actual wilt infection, and the few plants which failed to yield Fusarium were discarded. Seeds to be cultured were delinted with sulphuric acid, washed in running tap water, disinfected for one minute in 1–2000 solution of mercuric chloride in 25 per cent. alcohol, and finally rinsed three times in sterilized water. These surface-sterilized seeds were then planted in potato-dextrose agar in Petri dishes, usually placing 6 seeds per dish.

As summarized in Table 1, *Fusarium vasinfectum* was recovered from only a small percentage of the seeds during 1929 and 1930. During 1931, a larger percentage of the seeds showed internal infection with *F. vasinfectum*. In 1930, *F. vasinfectum* was recovered from the tap-roots, main stems, peduncles and some seeds from every boll of 9 of the 45 plants from which cultures were made. With the remaining 3 plants, the fungus was obtained from the tap-roots, main stems and peduncles, but not from the seeds of any of the bolls. With the 8 infected cotton plants cultured during 1931, *F. vasinfectum* was recovered from the tap-roots, main stems, peduncles and from some of the seeds from all the bolls from two plants. The remaining 6 plants yielded Fusarium from the tap-roots, main stems, peduncles, but not from the seeds. This work has demonstrated that *Fusarium vasinfectum* may be carried inside the seeds of cotton plants infected with Fusarium wilt, although it is not necessarily present in seeds even from plants with infected tap-roots, stems and peduncles.

In culturing the seeds from wilt-infected plants, it was noticed that many of the seeds which yielded *F. vasinfectum* had failed to germinate. It is obvious that the disease could nevertheless be transmitted by such dead seeds as well as inside the viable seeds.

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TABLE 1

Summary of Isolations of *Fusarium vasinfectum* from Seed from Wilt-infected Cotton Plants. The Plants were Brought in During the Early Fall, and Seeds were Cultured the Following Spring and Summer

| Year plants were selected | Number of plants from which seeds were cultured | Number of plants from which seeds yielded *F. vasinfectum* | Total number of seeds cultured | Per cent. of seeds which yielded *F. vasinfectum* |
|---|---|---|---|---|
| 1929 ... | 9 | 1 | 464 | 2.2 |
| 1930 ... | 45 | 9 | 4202 | 4.6 |
| 1931 ... | 9 | 2 | 428 | 23.7 |
| Total for 3 years | 63 | 12 | 5094 | 5.9 |

## BOOKS RECEIVED

Burrow, Trigant. *The Structure of Insanity.* Pp. 80. Baker & Taylor.

Fulton, John F. and Allen D. Keller. *The Sign of Babinski.* Pp. xi+165. 65 figures. Charles C. Thomas. $5.00.

Lothrop, Samuel K. *Indians of the Paraná Delta, Argentina.* Pp. 77–232. Illustrated. New York Academy of Sciences.

Parker, G. H. *Humoral Agents in Nervous Activity.* Pp. x+79. 19 figures. Cambridge University Press, Macmillan. $1.75.

Skinner, Ernest B. *Introduction to Trigonometry and Analytic Geometry.* Pp. xi+189. 87 figures. Macmillan. $1.80.

Thorndike, Edward L. *The Fundamentals of Learning.* Pp. xvii+638. 16 figures. Teachers College, Columbia University. $6.50.

Tresidder, Mary C. *The Trees of Yosemite.* Pp. xiv+133. Illustrated by Della T. Hoss. Stanford University Press.

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